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CONSTRUCTION OF ON-BOARD INSULATED FISH CONTAINERS FOR PIROGUES

prepared by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, May 1985

PREPARATION OF THIS DOCUMENT

This paper has been prepared by Fish Utilization and Marketing Service, Fishery Industries Division of FAO with aim to improve handling practices on board pirogues. Though experiments and tests have been done in Senegal, problems of preservation of fish on board pirogues exist also in many other countries. Mr N. Coackley, FAO Consultant designed the containers and supervised the construction of a few of them. Later he has prepared the report on which this document is based.

Construction and further evaluation of the containers have been carried out by Centre d'assistance d'armement traditionnel in Dakar, Thiaroye-sur-Mer (CAMP) under grant-in-aid provided by FAO (GCP/INT/398/NOR and Regular Programme Funds).

All pictures and drawings in this paper have been taken or prepared by N. Coackley.

This document in its final version has been prepared by Z. Karnicki (Fishery Industry Officer FAO, HQ).

ABSTRACT

Handling of fish on board pirogues still require a substantial improvement to maintain a good quality of fish. The insulated containers which allow to store the ice and later fish in ice on board pirogues going out for 3-5 days fishing trip in Senegal have been designed, constructed and tested with very good results. Ten containers of about 1.3 t of fish capacity have been made. This paper provides background information on all stages of construction, blueprints, breakdown of material required and cost involved. The production stages are illustrated with pictures.

The paper could be used as a manual on construction of such containers.

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1. INTRODUCTION

Handling of fish on board pirogues seldom received attention mainly due to the fact that trips are short, seldom exceeding one day. However, it has to be kept in mind that spoilage begins since the fish is dead and even a few hours in tropical ambient temperature can cause a significant degree of spoilage which due to further improper handling ashore leads to poor quality of fish on a market.

Very particular situations exist in Senegal where sufficiently large pirogues so called "icing pirogues" (pirogue glacier) are off for 3-5 days to fish with handlines for highly priced bottom species. Pirogues though so called "icing pirogues" seldom take ice with them to the sea as due to the lack of proper storage facilities, the ice is melting out quickly providing only marginal protection for fish.

Efforts have been made by local fishermen to construct a compartment or even container to keep ice and fish in ice but results were not very encouraging. Plywood or corrugated steel sheets did not provide sufficient insulation and ice still was melting too fast.

To improve the existing situation, FAO decided to assist fishermen in construction of properly designed and constructed containers made from the materials available locally. Ten such containers have been constructed and are under extended trials which will last about one year (till late 1984). However, information already available confirmed full usefulness of containers and their economic viability.

At least 200 such containers are required for Senegal and further work should be aimed toward adaptation of the containers for very large pirogues fishing for sardinella and other pelagic species.

2. WHY DO WE NEED INSULATED CONTAINERS?

It should be a main goal for fishermen to bring ashore a fish of the best possible quality. On larger boats with chilling facilities on board this is not a great problem, but it is not always easy to assure that fish brought by artisanal fishermen is equally good. Chilling fish with ice seems however, to be the only resolution, particularly if fishing grounds are a few hours away from the landing centre.

Chilling reduces activity of bacterias and enzymes and retards spoilage. Spoilage is not a reversible process and therefore it is important to retard it from the very beginning. Rate of spoilage depends on the temperature, time, as well as species of fish. This is illustrated in Figure 1.

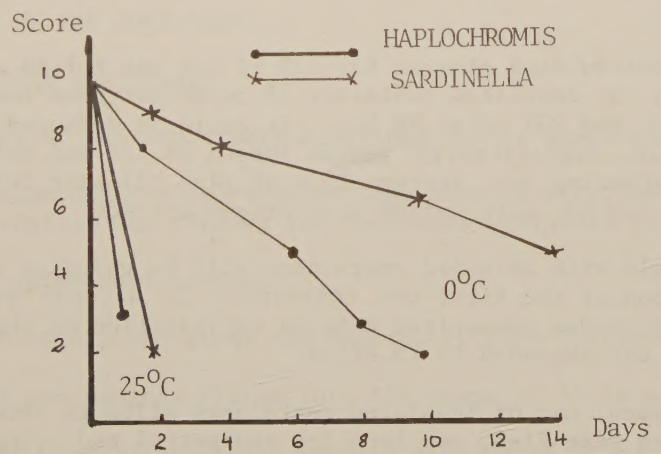


Figure 1 Spoilage rate of sardinella (*S. Aurita*) and *Haplochromis* sp. at 25°C (A), and 0°C (B), (after Mlay *et al.* and Diouf *et al.*, 1982)

Data provided in Figure 1 indicate that fish kept in temperature of 25°C become spoiled in one or two days, thus, kept in ice they will remain in good condition for a week and even longer.

Ice is a good cooling medium for fish as it has a large cooling capacity for a given volume. Crushed ice is better than block ice, as it enables the fish to be surrounded by small pieces of ice and thus cool rapidly. This is achieved by the heat from the warm fish flowing to the cold ice removing the heat of the fish and melting the ice.

Should the iced fish be stored in a simple wooden or plastic box melting of the ice will be accellerated by the proximity of the surrounding air with its higher temperature. The ice tries to chill everything in its immediate vicinity by conduction (transfer through the structure of the box material), diffusion (heat loss by evaporation), convection (heat loss by passage of air over cooled surfaces) and radiation (e.g., solar radiation) which plays a minor part but can warm the fish even after passing through a physical barrier.

Thus separating the ice or cooling fish by a substantial physical barrier of the correct materials (insulation) from hotter surroundings will reduce melting rate of ice, maintain a low temperature and thus prolong storage life of the iced fish.

Introduction of plastic boxes in the industrial fishery where they were used in insulated or chilled stores was a significant step forward in improving of handling practices, however, the plastic boxes cannot be recommended for artisanal fisheries due to high melting rate of ice (see Table 1).

Table 1

Average melting rates during storage of block ice

Average melting rates during storage of block ice			
	% melted after 12 hrs	% melted after 24 hrs	% melted after 48 hrs
Insulated container	7	12	23
Ice covered with sawdust	11	22	45
Uninsulated plastic box	53	90	-

(After Villadsen *et al.*)

As it can be seen in uninsulated plastic box 53% of ice was melted after 12 hrs and 90% after 24 hrs. Though in insulated container (5 cm polystyrene foam) melting loss was only 12% after 24 hrs and 23% after 48 hrs. It could be deducted therefore, that use of insulated containers significantly reduce losses of ice and help to maintain a low temperature thus extending the storage life of fish allowing for longer fishing trip or holding the fish during glut period when prices are low.

Though durability trials with on-board containers will be going on for a longer period information from exploitation of the first two containers is already available and very encouraging. Table 2 provides summarized data on exploitation of three pirogues during a three month period which corresponded to 15 trips.

As it clearly can be seen, use of insulated containers allow to extend the average trip from 3 to 5 days, bring more fish, use less ice and petrol and bring a top quality fish which pays well.

Table 2

Comparative results on use of on-board insulated fish containers

	Container 1 FAO	Container 2 FAO	Traditional container
No. of fishermen	6	6	8
Duration of trip	5	5	3
Ice (kg)	750	675	1 200
Petrol (litres)	110	100	130
Quantity of fish caught (kg)	1 226	1 253	1 017
Ambient temperature	27°-28°C	27°-28°C	27°-28°C
Quality of fish			
- 1st quality	69%	75%	8%
- 2nd quality	30%	25%	12%
- 3rd quality	1%	-	31%
- 4th quality	-	-	20%
- 5th quality	-	-	2%
Rejected	-	-	27%
Marketing value of the catch	CFAF 198 130	CFAF 181 130	CFAF 83 410

Note: data in the table represent the average per trip calculated on 15 trips.

(From: Rapport d'évaluation de la phase I, Projet: Amélioration de la conservation de poisson à bord des pirogues, CAPAS, Senegal 1983).

Seeing the difference in value of the fish from one trip and assuming the price of the container about CFAF 350 000 it can be said that the whole investment is paid back in four trips which is above the expectations of all involved and without exaggeration one can say for sure that construction and proper use of the insulated containers is a good and quickly paying back investment.

3. CONSTRUCTION OF THE CONTAINERS

3.1 Basic Data about Containers

The principles of the containers described in this paper are as follows:

- 10 cm of high density polyuretane foam covered with one layer of resin, reach 450 g/m^2 fibreglass mat forming the container walls and structure;
- insulated waterproof hatches;
- protection of exposed areas and decking to give further protection and shade;
- containers are roughly fitted into the shape of 14-18 m long pirogues;
- capacity of the container are about 0.9-1.3 t of fish;
- approximate weight of the container is: 200 kg (for two hatches) and 270 kg (for three hatch-version);
- containers are not permanently fixed into canoe and can be easily removed.

3.2 Materials Required

The materials that will be required to use will be primarily:

- Polyester resin;
- glassfibre mat and cloth;
- peroxide catalyst;
- cobalt accelerator;
- acetone;
- polyuretane foam;
- hardwood;
- playwood.

Detailed breakdown of the cost and material required are given in Table 3.

Table 3

Breakdown of the material required and the cost[1/] for construction of small and large on-board container

Material	Unit Price	Two hatch-container	CFA	Three hatch-container	CFA
Foam sheet 1.9x0.1x0.9	15 000 HT	8.5	127 500	11	165 000
Rasin/kg	825 HT	75	61 875	100 kg	82 500
Mat 450 gr/m^2	800 HT	34 m^2	27 200	45 m^2	36 000
PVC Tube/m	800 HT	0.6	480	0.6 m	480
12 mm Ply/sheet	7 227 HT	3	21 681	4	28 900
18 mm Ply/sheet	11 000 HT	2	22 000	3	33 000
Screw each	25 TT	25	500	20	500
Nails/kg	500 TT	2 kg	1 000	3 kg	1 500
Bois rouge/m^3	96 792 TT	15mx0.23x0.002	6 679	24mx0.23x0.02	10 686
Paint/Lt	2 500 TT	3Lt	7 500	3Lt	7 500
Rope/m	250 TT	1m	250	1m	250
Bois blanc/m^3	63 375 TT	35x0.23x0.02	10 203	40x0.23x0.02	11 661
TOTAL			286 868		377 977

1/ Material cost as for 1 January 1984 - US$ 1 = CFAF 360F HT = VAT and duty free, TT = items tax paid

3.3 Tools Required

The following tools are required in the making of the insulated on-board fish containers (Fig. 2): grinder, hammer, wood saw, old saw blades for scraping, tape measure, marking pen, stanley knife, paint brushes, plain wood 8 cm, laminating roller, omo-abrasive soap for hand cleaning, measuring tube for catalyst, square, hole saw, mixing/cleaning bucket.

As it can be seen only simple woodworking tools are necessary but if a circular saw is available to cut out straight, well-fitting edges to the foam sheets and a powered grinder to smooth off any hard resin drips or rough corners then the task will be easier.

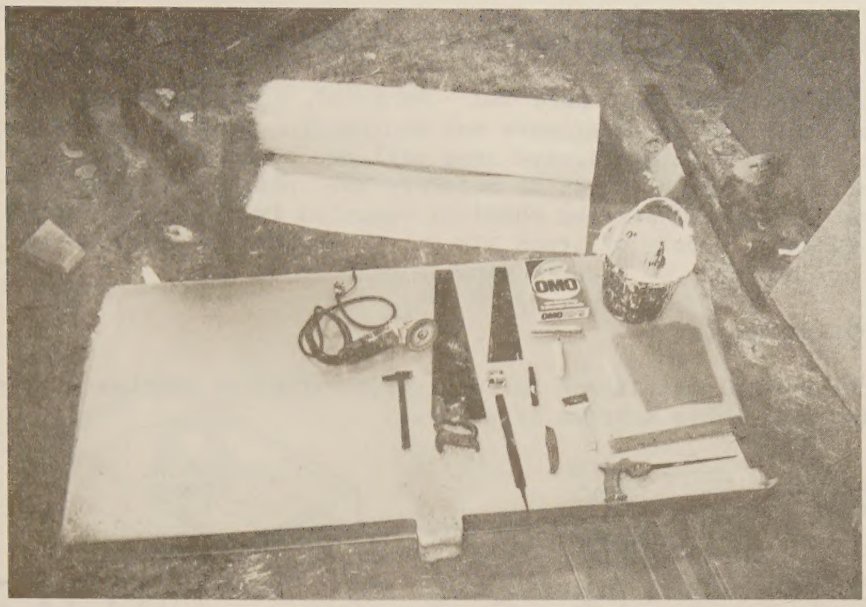


Figure 2 Tools used in the making of insulated fish containers

3.4 How to Make the Containers

3.4.1 General comments

The construction of insulated containers needs the supervision of a person who has previous practical experience of fibreglass materials as care and training in their use is necessary to achieve a satisfactory result and to ensure the safety of the persons handling the raw materials.

Such a person may have attended an FRP course at some time; be working in a boatyard or a factory producing FRP items such as car body panels or bathroom and toilet furniture or be an extension specialist already maintaining and repairing FRP boats. Once this key person is available, a carpenter and a helper would complete the team necessary to make a container in about one working week.

The team leader should be familiar with the materials listed above and their use but a reminder of their storage and safety requirements may be useful to the reader.

Polyester resin is a sweet smelling syruppy liquid and is stored in drums or tins. It needs to be kept cool and not exposed to sunlight or heat to attain a useful storage life of 3-6 months.

Glassfibre mat and cloth arrive in rolls like bolts of cloth and are inert. Mat can cause a rash on those parts of the body that come into contact with it. It must be kept clean and dry. Peroxide catalyst is a clear, oily liquid, corrosive, poisonous and inflammable. Store it securely in the plastic containers provided and wash hands IMMEDIATELY if any is spilled onto them. Cobalt accelerator is a purple liquid and can cause explosions when mixed directly with the catalyst. Always thoroughly mix the accelerator into the resin before adding the catalyst, better still is to buy a pre-accelerated resin, when none further will need to be added.

Acetone is a clear flammable liquid used for washing skin and tools. Keep the drum closed as it evaporates quickly.

The only material with which the team leader may not be familiar is polyurethane foam. He may have met white expanded polystyrene foam and already found that it is eaten away when polyester resin is applied. This does not happen with the pale yellow, small celled polyurethane foam. He may know that the former can be obtained in any size or shape and this applies to the polyurethane too.

In the case study following the sheet sizes were simply the largest size available and made at the required high density (hard) and thickness 10 cm.

The place to construct this need not be grand, but a local boatyard would be the first place to try on the basis of experience and equipment. If this is not possible then any shaded, dry, clean and well ventilated area will do. Shaded to prevent the sun's heat prematurely curing the resin. Dry, as moisture can spoil a resin mix, clean, as dirty or oily conditions can contaminate the chemical reaction in the resin curing process and well ventilated to ensure a supply of fresh air to the workers in order not to inhale fumes given off by the chemicals.

3.4.2 Construction details

The typical Senegalese pirogue is long narrow (Fig. 3) and has a triangular rather than rectangular hull cross section (Fig. 4).

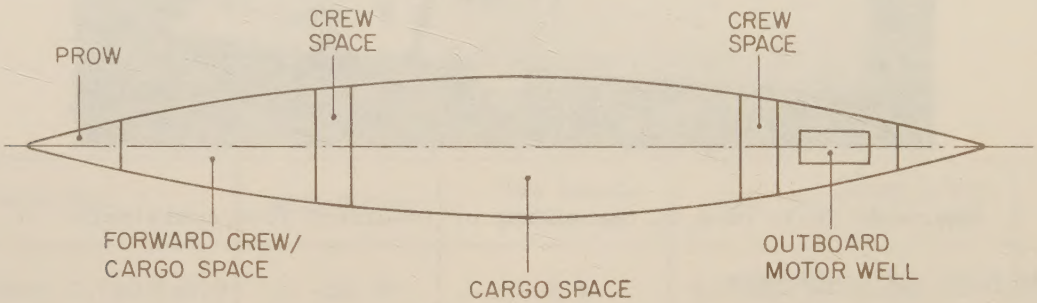


Figure 3 Typical 14 m pirogue compartments

The container should be fitted into the hull and capacity requirements determined along with the number of compartments for ice and fish.

Once made containers are simply placed on bottom boards within the hull, their own weight keeps them in place. The two hatch-container weighs approximately 200 kg and the three hatch-version 270 kg. They can be fitted with side handles to assist in carrying and require 6-10 persons to do so.

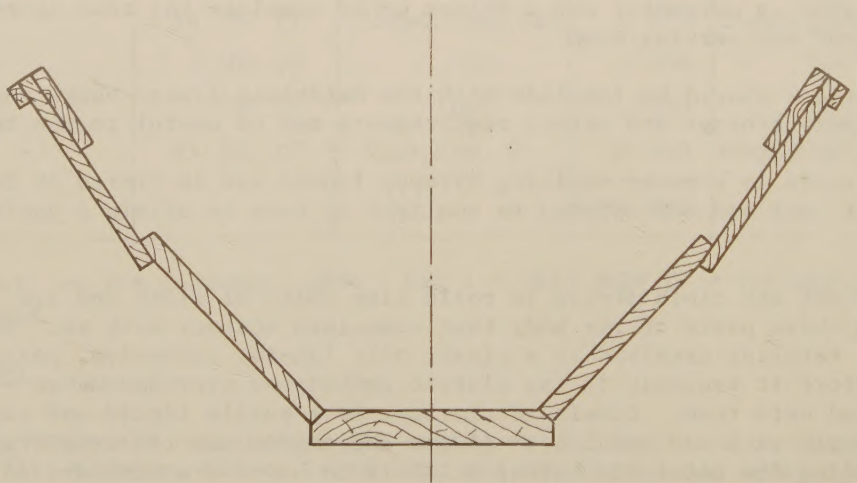


Figure 4 Typical cross section of 18 m Senegalese pirogue

Diagram and construction details of the two hatch container are given on Figures 5, 6 and 7.

The bulk of the work in the beginning is the preparation of the foam sheets to accept a layer of FRP and to be trimmed to shape to allow gluing together to form the basic unfibreglassed container shape. This consists of scraping the shiny moulded surface of the sheets (Fig. 8) with a saw blade to expose the wax and to expose the rough, cellular

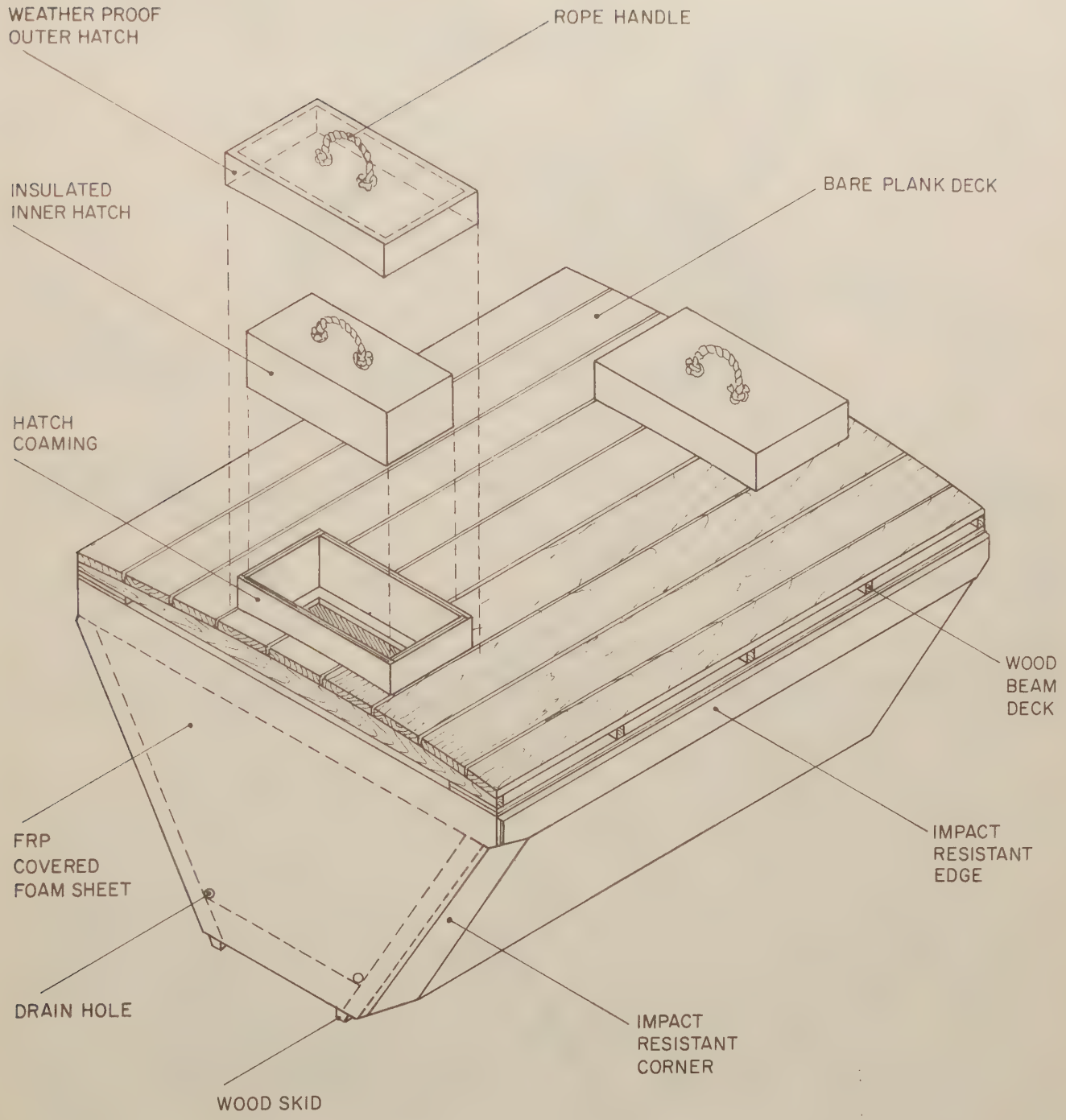


Figure 5 Sketch diagram of two hatch-container

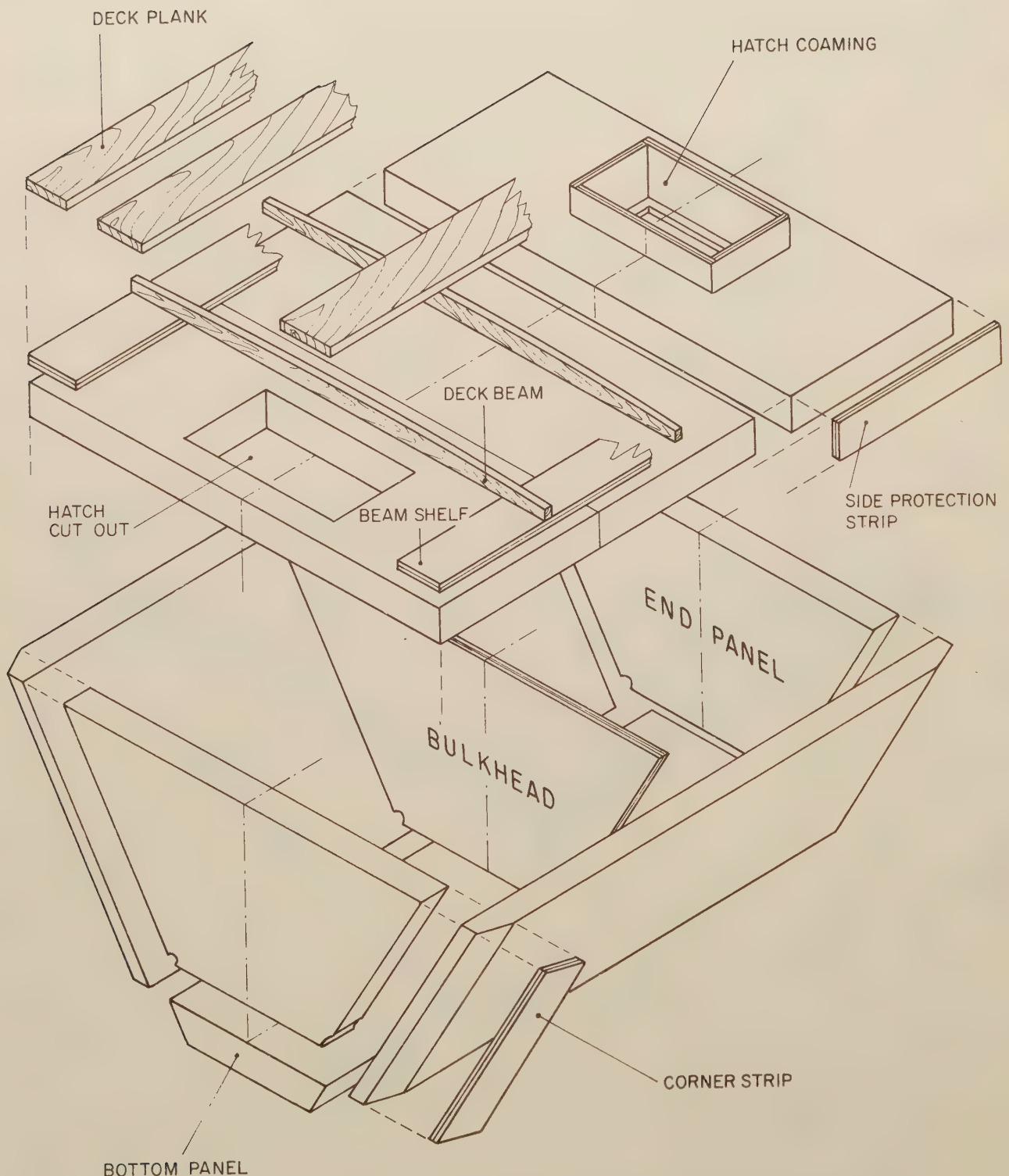
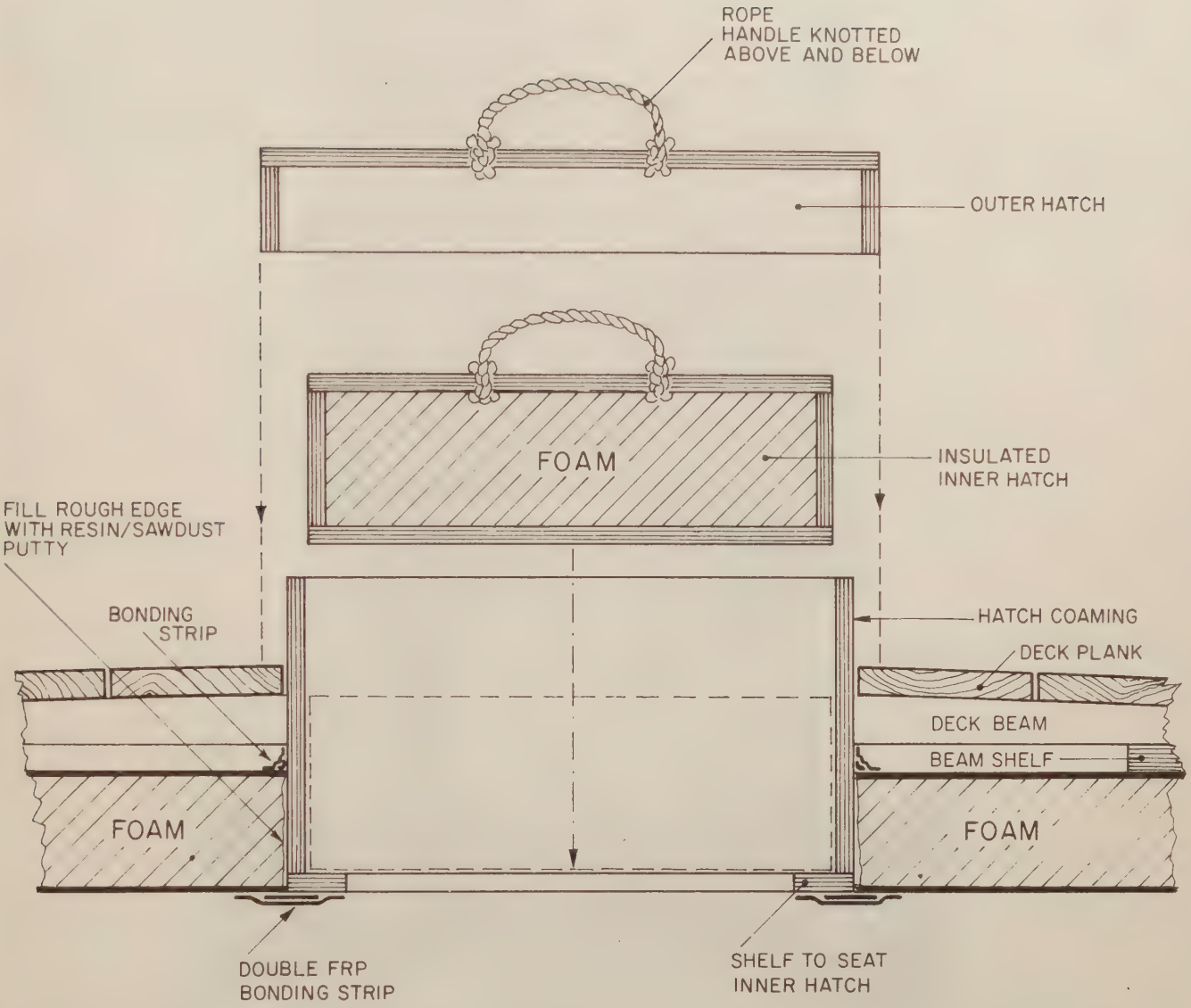


Figure 6 Exploded view of 2 hatch-container



NOTES:

No scale.

Hatch uses foam offcuts.

Hatch 60 cm sqare.

For use with FRP or wood container.

All exposed wood and foam FRP covered or resin coated.

Hatch coaming 19 mm waterproof plywood.

Hatches 12 mm waterproof plywood.

Figure 7 Typical hatch cross section for insulated container

foam of the sheet and to cut levels in the long edges with a template of the required angle to facilitate accurate glue lines. Both end panels are cut from one sheet, the second being given together from the adequate offcuts. Side and bottom panels are either 1 1/2 sheets for the 2 hatch-container or 2 sheets for the 3 hatch-container, end butt given and pegged (Fig. 9). Care must be taken to stagger the butts to avoid a continuous join passing right around the case. Good butt joints are achieved by squaring up sheet edges on a band or circular saw then giving with 'hot' or over catalysed mix of polyester resin on a flat floor with scrap cardboard below the joints to prevent the sheets being glued to the floor. Wood pegs at intervals ensured a mechanical join while the resin glue sets. These pegs are later snapped off and voids filled with any available waste resin to ensure strength and thermal isolation.

Figure 8 Scraping glossy waxed surface from foam sheets

Assembling the now lengthened side and bottom panels together with the ends proceeds in the same way having prepared plenty of long thin pegs from scrap wood or ply. Top and base preparation should proceed at the same time (Fig. 10).

Preparation of the base for covering with a layer of FRP both inside and out involves smoothing off any sharp corners to an even radius, filing down any rough, cured resin drips and cleaning to give a smooth particle free surface (Fig. 11) on which to apply the resin and mat. The same applies to the top (FRP on both surfaces) but here join lines need to be reinforced with an extra layer of mat and hatch openings cut out before the mat and resin is applied.

The hatch coaming should be installed on the top before joining to the base. These are square box shaped openings in waterproof or marine plywood which are bonded into the prepared holes in the top by strips of FRP to the upper and lower surfaces (Figs. 12, 13, 14).

The unit is then ready for joining together with the top placed onto the base after checking that the wood shelving is in place, bulkheads are secure, drain holes are clear and surrounding foam well sealed with resin so that water cannot enter the exposed foam and that the interior is clean (Fig. 15).

Figure 9 Gluing together containers ends and top ends from scrap

Figure 10 Assembling container from prepared panels. Note glue lines, drain hole of PVC tube and fixing peg being hammered in

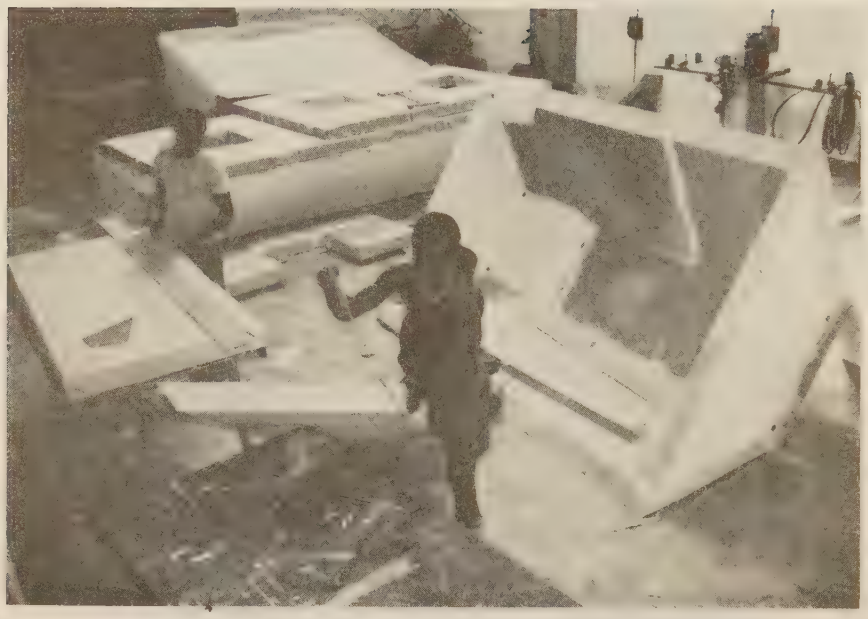
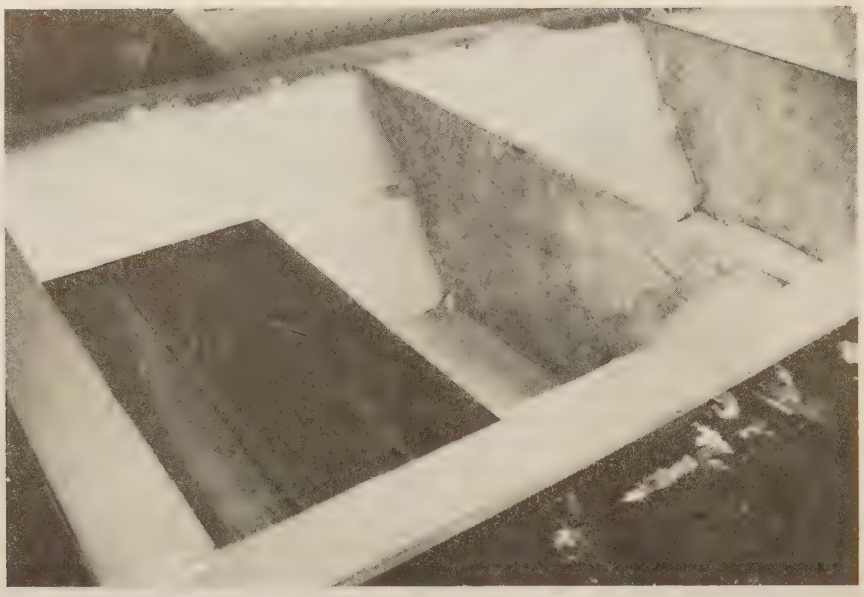


Figure 11 Preparing leveled side sheets, installing these offcuts as shelf ledge. Note staggered butts and bevel template

Figure 12 Mixing catalyst into pre-accelerated resin. Note precise measuring of catalyst quantity. THE LAST STEP BEFORE LAMINATING

Figure 13 Applying FRP layer to glued top panel. Showing natch openings, double thicknes joints, and tailored mat pieces

Figure 14 Top with plywood coamings bonded in place. (Also bonded on lower side). Note checking insulated hatch for fit



gure 15 Inside of container showing FRP layer, shelf ledge, mahogany shelf boards, resin coates ply bulkhead, bulkhead bonding and drain holes

It will soon be realized that inaccuracies in sheet size and cutting can be tolerated the thickness of the container walls and ease of cutting can absorb errors; likewise ps in foam joints can be filled with scrap foam and glued in place.

At this time, the top/side and top/end joint should be checked and trimmed to accept e protecting wood strips, deck beam shelf and the subsequent FRP bonding layer. Container rners need also to be trimmed back to accept protecting ply strips (Fig. 16, 17).

Figure 16 Wood skids temporarily nailed to underside of container ready for bonding in place. Skids may be of any size and can run along the length of the base as well as across it

Figure 17 Top showing cut out to accept ply protecting strips and beveled ply deck beam shelf temporarily nailed in place

Once this woodwork has been completed, the previously cut deck beams can be screwed onto the beam shelf and the untreated wood deck planking nailed to them. Bottom protection in the form of wood skids is bonded on and bare wood coaming surfaces resin coated. Finishing work includes making smooth by grinding off sharp edges and checking for water tightness. Coamings and hatches are then painted white. (Fig. 18 to 24).

Figure 18 Top ready for bonding to base. Showing previously bonder corner protection, deck beam shelf and top edge protection

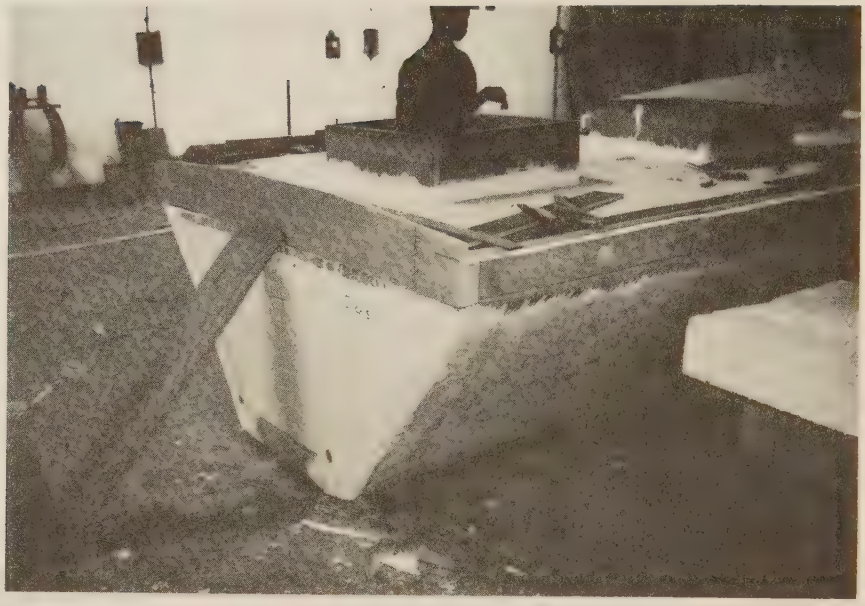
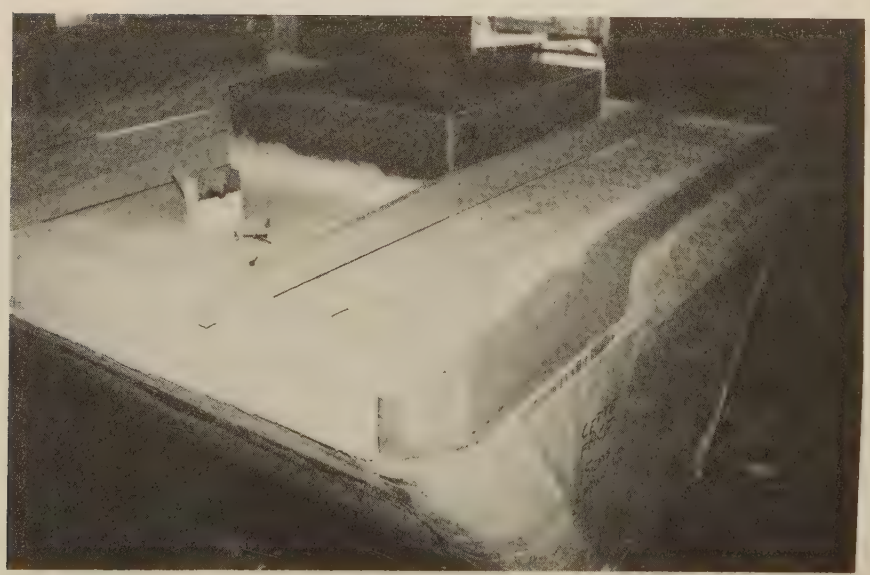


Figure 19 End deck beam propped in place while resin glue sets



ure 20 End deck beam partially bonded in place, beam shelf and edge strips bonded in and deck beams nailed to coaming ready for screwing to shelf. Note deck beams rest only on shelf thus transferring deck and crew weight to container sides

Figure 21 Nailing on deck of untreated sawn boards

Figure 22 Bonding internal join between top and case. This is a two-man operation made easier by the use of woven cloth tape. A pre-prepared strip of tape (30 cm) is impregnated with resin on a clean surface (scrap cardboard), a strip of mat is placed on top and also impregnated, when wet it is handed to the second man who, by the use of a brush, smoothes the strip into place on the interior join

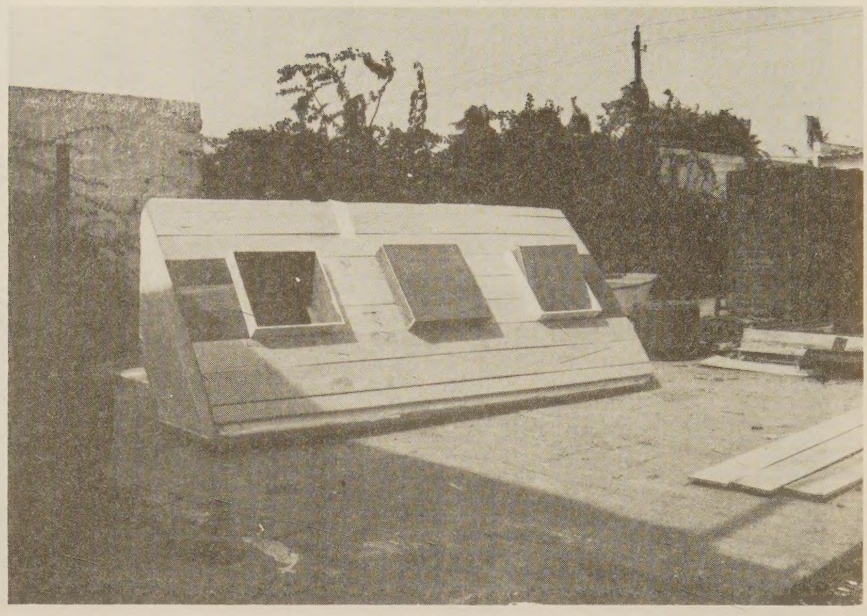


Figure 23 Finished container showing decking, open hatch, covered hatch and insulated inner hatch in place. Hatch corners are abraded and FRP coated, ply surfaces are resin coated and finally white painted

Figure 24 Finished container with standard end deck beam. Note gap between it and top surface

4. REPAIRS OF CONTAINERS

During utilization containers are suffering damages which have to be repaired. Figure 25 is showing damage after 4 month use.

It is important to mention that this container was not equipped with protecting strip nor a deck. It suffered the following damage:

1. Crushing of the foam in the area of one hatch due to dropping ice blocks during loading.

2. De-lamination due to water entering after thin FRP skin had been pierced and not repaired immediately.

3. Water soakage as in No. 2.

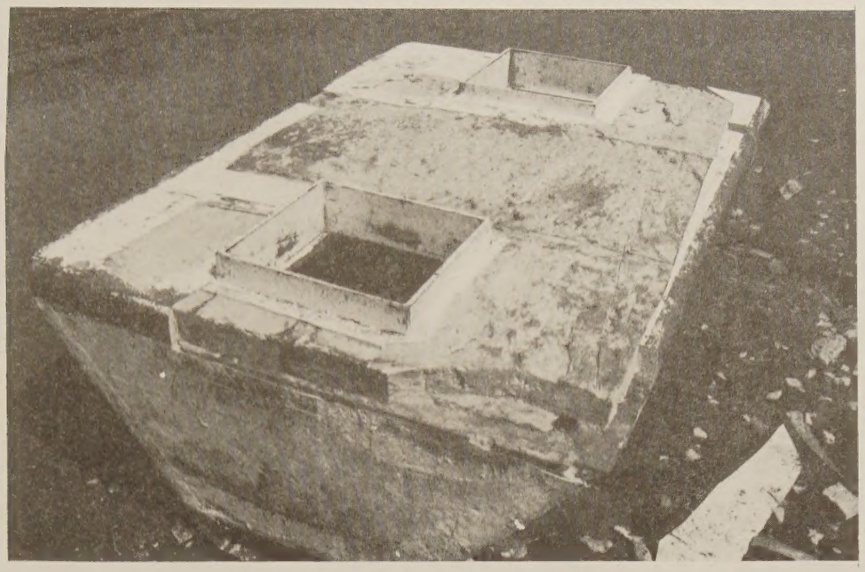


Figure 25 Damage of the first container after 4 month use

4. Corner crushing due to collision by pirogue coming alongside.

5. Bottom surface abrasion.

Repairs can be affected by removing damaged material, thoroughly drying out in the sun for several days and replacing damaged foam by gluing new in place followed by a new FRP skin.